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## Language Outcomes at 7 Years: Early Predictors and Co-Occurring Difficulties

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**Short title:** Early Predictors of Language Outcomes at 7 Years

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### Abbreviations

ELVS – Early Language in Victoria Study

SES – socioeconomic status

NESB – non-English-speaking background

OR – odds ratio

CI – confidence interval

AUC – area under the curve

CELF-4 - Clinical Evaluation of Language Fundamentals 4<sup>th</sup> Edition

SEIFA – Socio-Economic Indexes for Areas

PedsQL™ – Paediatric Quality of Life  
SDQ – Strengths and Difficulties Questionnaire  
WASI – Wechsler Abbreviated Scale of Intelligence  
WRAT4 – Wide Ranging Achievement Test 4<sup>th</sup> Edition  
SEB – social-emotional and behavioural  
HRQL – Health Related Quality of Life

**Table of Contents Summary:** The ability of early factors to predict low language abilities at 7 years is explored together with the degree and nature of co-occurring difficulties present.

**What's Known on This Subject:** Fluctuating pre-school language abilities present challenges for identifying children at risk of later language impairment. Child, family and environmental factors explain a limited amount of variability in language ability at 4 years and prediction of low language status is limited.

**What This Study Adds:**

Language scores at 4 years predict language scores at 7 years more saliently than early child, family and environmental factors. By age 7, children with low language have much higher rates of social-emotional, behavioural and literacy difficulties and HRQL limitations.

### **Contributors statement page**

Drs Reilly, McKean, Cook and Mensah designed the study, completed the data analyses, drafted the initial manuscript and approved the final manuscript as submitted

Drs Bavin, Bretherton, Eadie, Prior and Wake designed the longitudinal cohort study, revised the manuscript and approved the final manuscript for submission

Ms Conway and Cini designed data collection instruments, carried out preliminary data analyses and coordinated and supervised data collection, critically reviewed the manuscript and approved the final manuscript for submission

## Abstract

**Objective:** To examine at 7 years the language abilities of Australian children, the salience of early life factors and language scores as predictors of language outcome, and the co-occurrence of difficulties associated with low language.

**Methods:** *Design:* Longitudinal cohort study of 1910 infants recruited at age 8-10 months.

*Exposures:* Early life factors - Child gender, prematurity, birth weight/order, twin birth, socioeconomic status, non-English speaking background, family history of speech/language difficulties; Maternal - mental health, vocabulary, education, age; Child language – at ages 2 and 4 years. *Outcomes:* 7-year standardized language scores; low receptive and/or expressive language (scores  $\geq 1.25$  SD below the mean), co-occurring difficulties - autism, literacy, social, emotional and behavioural adjustment, and HRQL.

**Results:** 227/1204 (18.9%) children who provided outcome data met criteria for low language. Early life factors explained 9-13% of variation in language scores, increasing to 39-58% when child language at ages 2 and 4 years were added. Together, early life factors moderately discriminated between children with and without low language (area under the curve: 0.68-0.72), strengthening to good discrimination with language scores at ages 2 and 4 (area under the curve: 0.85-0.94). Low language at age 7 was associated with concurrent difficulties in literacy, social-emotional and behavioural difficulties, and limitations in school and psychosocial functioning.

**Conclusions:** Child language ability at 4 years was a more accurate predictor of low language at 7 than a range of early child, family and environmental factors. Low language at 7 years was associated with a higher prevalence of co-occurring difficulties.

Robust language development is required to meet the increasing social-relational and academic demands on children transitioning to formal schooling <sup>1</sup>. Yet between 7 and 20% of children experience low language in the pre-school and early school years<sup>2,3</sup> and are at heightened risk of difficulties with literacy, academic attainments and social-emotional and behavioural (SEB) adjustment <sup>4 5,6 7,8</sup>. These children are also at increased risk of experiencing poor mental health <sup>9</sup> and periods of unemployment in adulthood <sup>10 11</sup>.

However, we lack a detailed understanding of the natural history of language development from the pre-school to the early school years and it remains unclear at what age co-occurring difficulties emerge for children with low language. Hence identifying when and how best to intervene remains challenging.

Due to instability in child language development in the pre-school years, neither screening nor one-off direct assessments are sufficiently reliable to identify children at risk of persisting difficulties<sup>12-14</sup>. At least half of children with low expressive language abilities at 2 years catch-up with their peers by 4-5 years, and many 4-year-olds presenting with low language have previously attained language scores falling within the typical range at 2 years<sup>3</sup>. Further, of those presenting with low language at 7 years, in a community based study 46% previously attained typical language scores at 4, and conversely 39% of children with low language at 4 years had typical language by 7 years<sup>15</sup>. Hence a diagnostic approach, dichotomising children into those with and without language difficulties risks both over and under-servicing even from 4 – 7 years.

One approach has been to identify early risk and protective factors associated with later language outcomes to inform the design of primary preventative interventions<sup>16</sup> and targeted secondary prevention. Early life factors measured in infancy explain only a small amount of variance in language abilities at 4 years, but more than is explained at 2 years. Socio-

economic status (SES) has emerged as an increasingly important predictor of language and low language status between these two ages<sup>3,17</sup> suggesting that the salience of early life factors may change over a child's developmental trajectory. Whether the effects of early life factors increase or decrease between 4 and 7 years is unknown.

Little is known about the impact of low language on the individual's functioning and health related quality of life (HRQL),<sup>18</sup> the nature and degree of HRQL limitations experienced or the incidence of co-occurring conditions. Yet this is critical information required to inform appropriate preventative interventions. The burden of these difficulties in the population of children with low language, as opposed to only those clinically referred, remains poorly quantified<sup>19</sup>.

In a community ascertained cohort<sup>3,17</sup> the aims of this study were to 1) quantify the contribution of early life factors to 7-year language outcomes, specifically i) receptive and expressive language scores and ii) low language status; 2) determine whether these early life factors maintain salience once 2- and 4-year language abilities are considered; and 3) document co-occurring diagnoses of autism and difficulties in literacy, HRQL and/or SEB adjustment in 7 year old children with low language.

## **METHODS**

### **Sampling and Participants**

The Early Language in Victoria Study (ELVS) cohort was drawn from the population of infants aged 7.5 to 10 months living in 6 local government areas of Melbourne, Australia, in 2003, selected to represent high, medium and low SES using the census-based Socio-Economic Indexes for Areas (SEIFA). 1910 infants were recruited via the Maternal and Child Health Service with additional recruitment at hearing screening appointments and through press advertising; full details are reported elsewhere<sup>17</sup>. Parents unable to understand English sufficiently to respond to the questionnaires designed for a grade 6 reading level were

excluded. Participant retention across the 8 waves of data collection to 7-years is shown in figure 1. The in-scope sample for this analysis comprises 1204 children with complete direct receptive and expressive language assessment at 7 years. This manuscript extends previously reported outcomes at 1, 2 and 4 years in this cohort<sup>3,17</sup>.

## **Measures**

Measures were collected via parent report and direct assessments undertaken by trained research assistants.

### *Early Life Factors*

Twelve early life factors identified by the US Preventive Services Taskforce as potentially predictive of language development, and previously explored at 2 and 4 years, are included here. These comprised child factors: male gender, twin birth, preterm birth, birth order and birth weight; family factors: Non-English Speaking Background (NESB), family history of speech and/or language difficulties, and SES; and maternal factors: age, mental health, education, and vocabulary<sup>17,20</sup>.

NESB was defined where families reported that English was not the main language spoken to the child at home. The SEIFA Index of Relative Disadvantage is a census-derived measure of SES standardised for the population of Australia ( $M = 1000$ ;  $SD = 100$ ). Maternal vocabulary was measured using a modified version of the Mill Hill Vocabulary scale, a multiple choice test that yields a summed raw score with a maximum of 44<sup>21</sup>. Maternal mental health was dichotomised to 'no mental health problem' ( $< 4$ ) or 'likely mental health problems' ( $4 - 24$ ) using the Kessler Psychological Distress Scale (K6)<sup>22</sup>.

### *Early Language Measures*

At 2 years late talking was determined via parental report of children's vocabulary knowledge using the MacArthur-Bates Communicative Development Inventory – Words and



Sentences<sup>23</sup>. Using gender-specific norms, late-talkers were children with scores falling below the 10<sup>th</sup> centile.

At 4 years we administered the Clinical Evaluation of Language Fundamentals-Preschool Second Edition<sup>24</sup> (CELF-P2), yielding receptive and expressive standard scores' (M = 100; SD = 15).

### *Outcomes*

Language at 7 years was measured using the CELF-4 Australian Standardisation<sup>20</sup>. Low language was defined as a receptive or expressive standard score that fell  $\geq 1.25$  SDs below the published normative population means (i.e.  $\leq 81$ ). This follows precedent in previous studies in ELVS allowing for direct comparison between earlier and later data waves.<sup>3</sup>

Outcomes were examined for difficulties known to be associated with low language in clinical populations and for which robust measures were included in data collection at 7 years; namely, low non-verbal IQ, diagnosis of an Autistic Spectrum Disorder (ASD), literacy difficulties, SEB difficulties and limitations in HRQL. Non-verbal skills were measured using the block design and matrices subtests of the Wechsler Abbreviated Scale of Intelligence (WASI)<sup>25</sup>, with low non-verbal ability defined as a score falling  $\geq 1.25$  SDs below the published normative population mean<sup>25</sup>. Children with a diagnosis of ASD were identified through parental report and confirmed via follow-up telephone interview by the authors (MP or PE). SEB difficulties were identified using the Strengths and Difficulties Questionnaire (SDQ)<sup>26</sup> and the clinical cut-points for an 'abnormal' score applied. Literacy difficulties were determined using an adapted version of the Wide Range Achievement Test 4<sup>th</sup> Edition (WRAT-4), where scores across reading and spelling subtests were summed and scaled. In the absence of population norms, literacy scores falling  $\geq 1.25$  SDs below the sample mean were classified as 'impaired'. Health Related Quality of Life was measured using the parent-reported Pediatric Quality of Life Scale<sup>27</sup> (PedsQL<sup>TM</sup>) and 'limitations' in

HRQL were defined as scores falling  $\geq 1$  SD below the sample mean, a level found to be similar to that of children with severe and/or chronic health conditions such as rheumatic conditions and newly diagnosed cancer in a large population sample<sup>28</sup>.

## **Analyses**

1204 children completed the receptive and expressive language assessment at 7 years. To quantify the contribution of early life factors to 7-year language outcomes (aim 1) multivariate linear regressions were fitted to the CELF-4 outcomes and the coefficient of determination ( $R^2$ ) derived. Multivariate logistic regression models were fitted to the binary outcome 'low language status' deriving the Area under the Curve (AUC). To determine whether these early factors have measurable effects once later language and non-verbal IQ measures are considered (aim 2) these regression analyses were repeated using, in turn, the following predictors: (1) the 12 early life factors described above; (2) the 12 factors plus 2-year-old late-talker status; (3) the 12 factors, 2-year-old late-talker status plus 4-year-old language scores; (4) 4-year-old language scores only. The  $R^2$  and AUC values of these models were examined to quantify and compare the ability of the models to predict 7-year language or language status. The proportions with co-occurring difficulties (aim 3) were estimated with 95% confidence intervals (CI) in 7-year-old children with and without low language, and these proportions were compared using univariable logistic regression. To investigate whether sample attrition had affected the inferences drawn, the sample of 1204 children with complete language data at 7-years were re-weighted to be representative of the initial cohort with regard to the 12 early life factors. Weights were derived using the inverse predicted probabilities of participation estimated by a logistic regression model. Multiple imputation was used to account for missing predictor variables<sup>29,30</sup>. A series of 50 datasets were derived using chained equations to implement an imputation model including the explanatory and outcome variables considered in the analyses. As results were similar we

present the findings based on the complete and un-weighted data. Analyses were implemented in Stata 13.0 (Stata Corp, College Station, TX). All analyses were also repeated with the CELF-4 core language score as the outcome. Again results were similar and so we present only the findings for receptive and expressive language outcomes to enable direct comparison with previous research.<sup>3</sup>

## RESULTS

Participant retention at 7-years is summarised in Figure 1 and the characteristics of the participants (N = 1204) and non-participants (N = 706) are compared in Table 1. Participating families were more likely to be socially advantaged, have mothers who were more highly educated and less likely to speak a language other than English. 227 (18.9%) children were categorised as having either low receptive language (198; 16.4%) or low expressive language (111; 9.2%) but of these 82 children (6.8%) had low scores in both domains. This means 29 (2.4%) children had only expressive language difficulties and 116 (9.6%) only receptive difficulties. Hence it must be borne in mind when interpreting these data that many children in the receptive and expressive groups had mixed impairments.

In the linear regression analyses examining associations between early life factors and language ability at 7 (Table 2 – aim 1), mean CELF-4 standard scores were higher for girls than boys (4.3 points for receptive and 2.4 for expressive language) and for children of mothers with a university degree when compared to those who did not finish school (3.4 receptive, 4.1 expressive). There was a clear effect of parity; first-born children had higher language scores, and twin birth was associated with lower expressive language scores (5.6 points lower than singletons). A family history of speech and/or language difficulties was associated with lower receptive language (2.7 points), and lower SES and poorer maternal vocabulary knowledge were associated with lower language scores. For every 100 unit

increase in SEIFA scores, receptive language scores increased by 2.2 points and expressive by 2.3.

Together the early life factors accounted for 9% and 13% of the variation in receptive and expressive language standard scores respectively at 7-years (Table 3 – aim 2). Together the addition of 2-year late-talker status and 4-year language scores increased the variation explained to 39% for receptive and 58% expressive language. Language scores alone at 4 years (without the early life factors or late-talker status) produced almost identical  $R^2$  values, explaining 37% and 56% of 7-year receptive and expressive scores.

In the Logistic Regression analyses (Table 2 – aim 1) the same factors as for the linear regression, with the exception of twin birth, were significant predictors of 7-year low language status. The AUC values in Table 3 (aim 2) quantify the ability of the predictor variables to discriminate between 7-year-olds with and without low language. An AUC value of 0.5 indicates chance discrimination, .7 to .8 moderate, .8 to .9 good and 1 indicates perfect discrimination.

The early life factors alone reached only a ‘moderate’ level of discrimination (receptive: .68; expressive: .72)<sup>31</sup>. Together the addition of both 2-years late-talker status and 4-years language scores improved the model’s ability to discriminate to a ‘good’ level for receptive language (.85) and to an ‘excellent’ level for expressive language (.94). Notably, almost identical AUC values were found when only 4-year language measures were used as predictors (receptive: .84 receptive; expressive: .93), without the addition of the early life factors and late-talker status.

The prevalence of co-occurring difficulties (autism, low non-verbal IQ, literacy difficulties, SEB difficulties) and limitations in HRQL were significantly higher for children with low language at 7 years than for their peers with Typical Language. Two subtypes of socio-emotional problems as measured by the SDQ (low pro-social scores and emotional

difficulties) were not significantly different between the two groups, although prevalence of low pro-social scores was significantly raised for children with low expressive language but not receptive. A high proportion of children with low language also had literacy difficulties (37.2% receptive, 48.6% expressive), as well as limitations in their HRQL in the domains of school (32.1% receptive, 36.0% expressive) and psychosocial functioning (27.6% receptive, 31.3% expressive). It must be noted that only 29 children had isolated expressive language difficulties. Children, with only expressive difficulties experienced lower levels of co-occurring difficulties than those with mixed expressive-receptive difficulties. However, given the very low numbers estimates of co-occurrence for these subgroups are not presented here due to concerns regarding reliability.

Following multiple imputation to address missing predictors and weighting to reflect the sample characteristics at baseline, no substantive differences were identified in the estimates of the prevalence of comorbidities to those with complete data. For the regression analyses differences were minimal; however, some effects were diluted when missing data were addressed (e.g. SEIFA, family history of speech and/or language difficulties, and maternal vocabulary).

## DISCUSSION

At 7 years a range of early child, family and maternal factors collectively explained 9% of receptive and 13% of expressive language outcomes. Whilst it was less than explained at 4 years (19% and 21%)<sup>3</sup> it was higher than at 2 years (4% and 7%)<sup>17</sup> in the same cohort.

Together, these predictors moderately discriminated between children with typical language and those with low language at 7 years. Whereas late-talker status did not substantially improve discrimination, the further addition of language scores at 4 years improved discrimination to 'good' or 'excellent' levels. Similar levels of discrimination were obtained

when only 4-year language scores were used to predict 7-year-old language suggesting language abilities are more stable between 4 and 7 than between 2 and 4 years.

Children with low language at 7 years were more likely to have low IQ, autism, SEB difficulties and literacy difficulties than their peers with typical language and rates of comorbid literacy difficulties were particularly high (37% and 49%). Children with low language were 2-3 times more likely than their peers to have SEB difficulties. Given the relationship reported between low language in childhood and later mental health outcomes in adulthood, this concurrent finding at 7 years suggests this relationship begins early.<sup>9,10</sup> To our knowledge this is the first time an association between low language abilities and HRQL has been reported in childhood in a community sample. Of concern is that these children were experiencing limitations in school and psychosocial functioning equivalent to those experienced by children with chronic and severe health conditions and with more than twice the frequency reported in their peers with typical language.<sup>28</sup>

A number of factors that were predictive of language outcomes at 4 years (NESB, maternal age, family history of speech and/or language problems and birth weight) were not at 7 years in this cohort. One explanation for these diminished effects may be that universal access to schooling serves to partly compensate for early life factors, for example children from a NESB catch-up with their monolingual peers when given access to English speaking environments.<sup>32</sup> In addition as 'young' mothers mature perhaps they are able to provide more supportive home learning environments.<sup>33,34</sup>

Between 2 and 4 years<sup>3</sup> we found an increase in the contribution of social and environmental factors to children's language outcomes. However from 4 to 7 years the salience of these factors (e.g. SES, maternal education) were substantively unchanged. Age 4 language scores alone yielded similar levels of prediction as models including late-talker status and early life factors. This suggests that most of the variability explained by the early life factors is

mediated by a measure of language at 4 years. It would appear therefore that the associations between the early life factors measured here and a child's relative language abilities have played out by age 4. However it is important to note that a child's relative language ability at 4 is not entirely fixed and factors such as the frequency of being read to and the number of children's books in the home are associated with change in relative ability from 4 to 7 years, albeit with small effects.<sup>16</sup>

The strengths of the ELVS study include the cohort of children that reflects a broad spectrum of the community, the prospective, longitudinal data collection, repeated robust language measures and concurrent measures of other aspects of child development. Inevitably sample attrition has occurred and there are missing data. However, the similarity of findings when inverse probability weighting and multiple imputation were implemented provides assurance that the results presented are reflective of the original cohort. The inclusion of a child's access to speech pathology interventions and its relationship to child outcome would have strengthened the study. The ELVS data allowed the identification of the proportion of children with low language at 4 and 7 years who had received some form of speech pathology intervention (4 years - 38% receptive, 40% expressive; 7 years – 28% receptive, 39% expressive). However insufficient information was available to draw reliable conclusions as to the amount, type and quality of the therapy received, precluding its inclusion in analyses.

## CONCLUSIONS

Low language at 7 years is prevalent and associated with poor literacy and SEB adjustment. Furthermore these 7-year-olds experience limitations in school and psychosocial functioning at twice the rate reported in peers with typical language.<sup>28</sup> Whilst the results reported here suggest education and health services could reasonably estimate a child's risk for persisting low language abilities at 7 years based on assessment of their language abilities at 4, one-off language assessments at this age that categorise children as with or without low language has

proven insufficiently reliable as the sole means of appropriate targeting of language interventions.<sup>35</sup> In this cohort, 6.2% had low language at 4 but not 7 years, 8.4% at 7 but not at 4 years, and 9.8% at both timepoints.<sup>15</sup>

Future research should be directed towards developing and robustly evaluating child language surveillance and intervention pathways over the early school years. Such pathways should include reliable and low-burden language assessment tools within a holistic surveillance approach, monitoring language development alongside key domains, such as literacy and psychosocial functioning. Tiered interventions must be developed and evaluated which are tailored to the severity of language and associated difficulties and risks experienced by the child. Evaluation of such pathways must weigh the relative burden, cost and benefits of over and under servicing for children given the instability in children's language status which continues from 4 to 7 years.

We recommend monitoring the progress of children with low language at 4 years through the early school years with respect to language, literacy and psychosocial functioning.

Additionally, where children present with literacy or psychosocial difficulties over this period their language abilities should be investigated. It is essential that schools recognise the vital role that oral language skills play in children's social and emotional adjustment and acquisition of literacy<sup>36</sup> and that they be equipped and supported to promote robust oral language development for all children.

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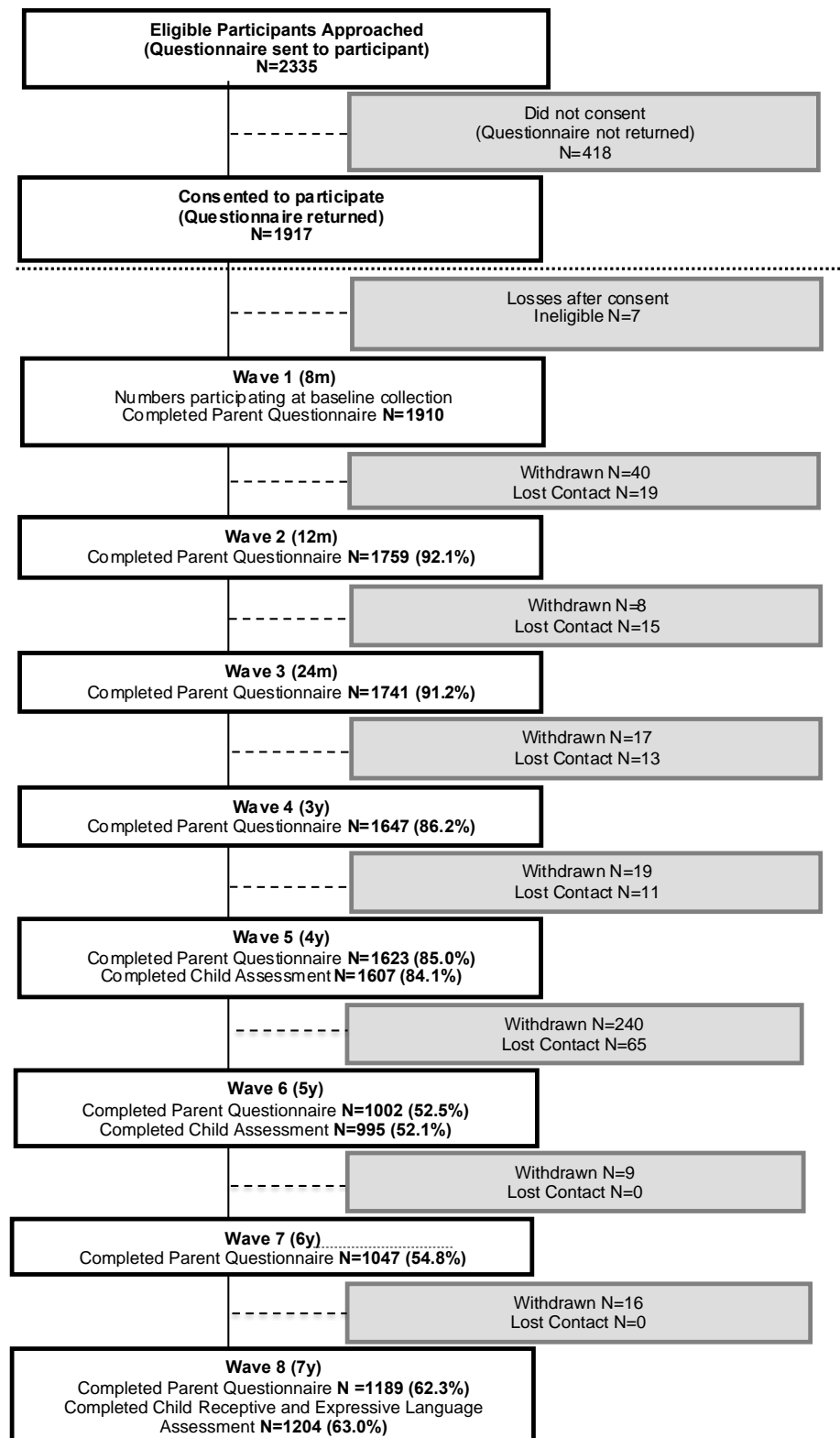


Figure 1. Participant flowchart from Wave 1 (8 months) to Wave 8 (7 years). Denominator for percentages is number participating at baseline (N=1910).

TABLE 1 Characteristics at Baseline and Wave 2 of Children Participating and Lost to Follow-up at 7 years

Baseline and Wave 2 Characteristics	Did not complete at 7y (N=706)	Completed at 7y (N=1204)	p
Female, %	46.7	51.1	0.07
Twin birth, %	3.5	2.3	0.12
Preterm birth (<36 wk), %	2.8	3.2	0.62
Birth weight (kg), mean $\pm$ SD	3.4 $\pm$ 0.6	3.5 $\pm$ 0.5	0.04
Birth order, %			0.07
First	48.9	50.8	
Second	38.2	33.7	
Third	9.9	13.1	
Fourth or later	3.0	2.5	
NESB, %	10.8	3.4	<.001
Maternal education level, %			
$\leq$ 12y	28.6	20.5	<.001
13y	41.3	39.5	
Degree/postgraduate	30.1	40.1	
SEIFA score, mean $\pm$ SD	1028.2 $\pm$ 67.2	1040.6 $\pm$ 56.1	<.001
Family history of speech/language difficulties, %	26.1	24.2	0.36
Maternal mental health symptoms, %	30.0	32.6	0.28
Maternal vocabulary score, mean $\pm$ SD	26.2 $\pm$ 5.6	28.2 $\pm$ 4.7	<.001
Maternal age at baseline, mean $\pm$ SD	31.4 $\pm$ 4.8	32.1 $\pm$ 4.4	<.001

Participants completed direct assessment of both receptive and expressive language at 7 years.

Child age at 7 year assessment, mean  $\pm$ SD, 88.3  $\pm$ 2.2 months

p values were derived through comparisons between those completing 7-year assessment and those lost to follow-up using either chi-squared tests for categorical variables or t-tests for continuous variables

TABLE 2 Multiple Variable Linear Regression Analysis of CELF-4 Standard Scores and Logistic Regression Analysis of Language Status at 7 Years with Respect to Early Life Factors

	Language (N=1132) <sup>a</sup>						Low language status (N=1132) <sup>a</sup>					
	Receptive			Expressive			Receptive			Expressive		
	Mean diff <sup>b</sup>	(95% CI)	p	Mean diff	(95% CI)	p	Odds ratio	(95% CI)	p	Odds ratio	(95% CI)	p
Child												
Female	4.3	(2.7, 5.9)	<.001	2.4	(0.9, 3.9)	0.002	0.57	(0.41, 0.80)	0.001	0.54	(0.35, 0.84)	0.007
Twin birth	-3.0	(-8.6, 2.6)	0.29	-5.6	(-10.9, -0.2)	0.04	1.46	(0.50, 4.31)	0.49	1.68	(0.50, 5.65)	0.40
Preterm birth (<36 wk)	1.0	(-3.9, 5.9)	0.69	0.7	(-4.0, 5.4)	0.78	0.95	(0.36, 2.54)	0.92	1.26	(0.42, 3.79)	0.68
Birth weight (per kg)	1.2	(-0.5, 2.9)	0.16	1.5	(-0.1, 3.1)	0.07	0.84	(0.59, 1.20)	0.35	0.73	(0.47, 1.14)	0.17
Birth order												
First	(ref)			(ref)			(ref)			(ref)		
Second	-1.6	(-3.4, 0.2)	0.07	-2.9	(-4.6, -1.2)	0.001	1.26	(0.85, 1.86)	0.25	1.36	(0.81, 2.26)	0.24
Third	-4.1	(-6.6, -1.5)	0.002	-6.3	(-8.7, -3.9)	<.001	1.65	(0.99, 2.74)	0.06	2.22	(1.19, 4.13)	0.01
Fourth or later	-5.3	(-10.6, 0.0)	0.05	-8.9	(-14.0, -3.9)	0.001	2.11	(0.82, 5.44)	0.12	3.02	(1.02, 8.98)	0.05
Family												
NESB	2.3	(-2.4, 7.0)	0.35	0.9	(-3.6, 5.4)	0.68	0.63	(0.23, 1.77)	0.38	0.95	(0.3, 3.04)	0.94
SEIFA score (per 100 points)	2.2	(0.7, 3.6)	0.003	2.3	(0.9, 3.7)	0.001	0.61	(0.46, 0.80)	0.001	0.58	(0.41, 0.82)	0.002
Family history of speech/language difficulties	-2.7	(-4.6, -0.9)	0.004	-1.5	(-3.3, 0.2)	0.09	1.46	(1.00, 2.11)	0.05	1.09	(0.66, 1.78)	0.74
Mother												
Maternal education level												
<=12y	(ref)			(ref)			(ref)			(ref)		
13y	0.9	(-1.2, 3.1)	0.39	0.7	(-1.3, 2.8)	0.49	0.86	(0.57, 1.31)	0.49	0.89	(0.53, 1.48)	0.64
Degree/postgraduate	3.4	(1.2, 5.6)	0.003	4.1	(2.0, 6.3)	<.001	0.59	(0.37, 0.94)	0.03	0.41	(0.22, 0.78)	0.006
Maternal mental health symptoms	0.3	(-1.3, 2.0)	0.69	0.4	(-1.2, 2.0)	0.63	0.94	(0.66, 1.34)	0.72	1.02	(0.65, 1.61)	0.92
Maternal vocabulary score (per point)	0.3	(0.1, 0.5)	0.003	0.4	(0.3, 0.6)	<.001	0.95	(0.91, 0.99)	0.01	0.95	(0.90, 1.0)	0.03
Maternal age at baseline (per year)	0.1	(-0.1, 0.3)	0.35	0.2	(0.0, 0.3)	0.11	0.99	(0.95, 1.03)	0.69	1.01	(0.96, 1.06)	0.71

<sup>a</sup> children with complete predictor and outcome data <sup>b</sup> mean difference refers to the average difference between the reference group (e.g. boys) and the comparator group (e.g. girls) in the outcome (e.g. receptive language score)

TABLE 3. Proportion of Variance in CELF-4 Standard Scores Explained and Accuracy of Predictors in Discriminating between Children with and without Low Language Status at 7 years

Model	N <sup>a</sup>	Language <sup>b</sup>		Low language status <sup>c</sup>			
		Receptive	Expressive	Receptive		Expressive	
		R <sup>2</sup>	R <sup>2</sup>	AUC <sup>d</sup>	95% CI	AUC	95% CI
(1) Predictors (n=12) in infancy only	1132	0.09	0.13	0.68	(0.64, 0.72)	0.72	(0.67, 0.77)
(2) As (1) plus late talking status (2-years)	1084	0.14	0.20	0.72	(0.68, 0.76)	0.82	(0.78, 0.86)
(3) As (2) plus receptive and expressive language scores (4-years)	1026	0.39	0.58	0.85	(0.82, 0.89)	0.94	(0.92, 0.96)
(4) Receptive and expressive language scores ONLY (age 4)	1132	0.37	0.56	0.84	(0.81, 0.88)	0.93	(0.91, 0.95)

<sup>a</sup> children with complete predictor and outcome data <sup>b</sup> Linear Regression <sup>c</sup> Logistic Regression <sup>d</sup> AUC value of 0.5 indicates chance discrimination, .7 to .8 moderate, .8 to .9 good and 1 indicates perfect discrimination

TABLE 4. Prevalence of co-occurring difficulties in children with Low Language at 7 years versus those with Typical Language

	Total N <sup>a</sup>	Receptive					Expressive				
		Typical Language N = 1006 <sup>b</sup>		Low Language N = 198 <sup>b</sup>		p	Typical Language N = 1093 <sup>b</sup>		Low Language N = 111 <sup>b</sup>		p
		%	95% CI	%	95% CI		%	95% CI	%	95% CI	
Autism	1204	1.6	(1.0 – 2.6)	6.1	(3.5 – 10.4)	<.001	1.6	(1.0 – 2.6)	9.0	(4.9 – 16.0)	<.001
Low non-verbal IQ	1197	0.5	(0.2 – 1.2)	10.8	(7.1 – 16.0)	<.001	1.2	(0.7 – 2.0)	12.0	(7.1 – 19.7)	<.001
Literacy Difficulties	1199	9.5	(7.8 – 11.4)	37.2	(30.7 – 44.2)	<.001	10.6	(8.9 – 12.5)	48.6	(39.3 – 58.0)	<.001
Social-emotional and behavioural difficulties											
Emotional Symptoms	1070	7.6	(6.0 – 9.5)	12.3	(8.0 – 18.3)	0.05	7.8	(6.3 – 9.7)	13.5	(8.0 – 22.0)	0.06
Conduct Problems	1070	7.3	(5.8 – 9.2)	17.2	(12.1 – 23.8)	0.001	7.9	(6.4 – 9.8)	17.7	(11.3 – 26.7)	0.002
Hyperactivity/Inattention	1070	7.4	(5.8 – 9.3)	20.9	(15.3 – 27.8)	<.001	8.3	(6.7 – 10.2)	20.8	(13.8 – 30.2)	<.001
Peer Problems	1069	5.1	(3.8 – 6.7)	12.3	(8.0 – 18.3)	0.001	5.7	(4.4 – 7.3)	11.5	(6.4 – 19.6)	0.03
Low Pro-social Behaviour	1070	2.2	(1.4 – 3.4)	4.9	(2.5 – 9.5)	0.05	2.2	(1.4 – 3.3)	7.3	(3.5 – 14.6)	0.005
Total Difficulties	1070	3.9	(2.8 – 5.3)	14.7	(10.1 – 21.1)	<.001	4.4	(3.3 – 5.9)	16.7	(10.4 – 25.6)	<.001
Quality of Life											
Physical Health	1068	10.4	(8.6 – 12.6)	16.7	(11.6 – 23.1)	0.02	10.4	(8.6 – 12.5)	20.8	(13.8 – 30.2)	0.003
Emotional Functioning	1069	12.4	(10.4 – 14.7)	21.5	(15.8 – 28.5)	0.002	12.8	(10.9 – 15.1)	22.9	(15.6 – 32.4)	0.007
Social Functioning	1069	14.0	(11.9 – 16.4)	23.9	(18.0 – 31.1)	0.002	14.4	(12.3 – 16.7)	27.0	(19.1 – 36.9)	.0001
School Functioning	1034	12.9	(10.8 – 15.3)	32.1	(25.2 – 39.8)	<.001	13.9	(11.8 – 16.2)	36.0	(26.6 – 46.5)	<.001
Psychosocial Functioning <sup>c</sup>	1069	13.2	(11.2 – 15.6)	27.6	(21.3 – 35.0)	<.001	13.8	(11.8 – 16.2)	31.3	(22.7 – 41.2)	<.001
Total score	1069	12.4	(10.4 – 14.7)	27.0	(20.7 – 34.4)	<.001	13.1	(11.1 – 15.3)	30.2	(21.8 – 40.2)	<.001

<sup>a</sup> Numbers differ due to missing outcome variables and test scoring guidelines with respect to handling missing responses<sup>b</sup> In sample of 1204 children with complete expressive and receptive language data at 7 years<sup>c</sup> This is a composite derived from the Emotional, Social and School Functioning subscales